

HONG KONG INSTITUTE FOR MONETARY RESEARCH

**SWITCHING COST AND DEPOSIT DEMAND IN
CHINA**

Chun-Yu Ho

HKIMR Working Paper No.06/2014

March 2014



Hong Kong Institute for Monetary Research
(a company incorporated with limited liability)

All rights reserved.

Reproduction for educational and non-commercial purposes is permitted provided that the source is acknowledged.

Switching Cost and Deposit Demand in China*

Chun-Yu Ho**

Shanghai Jiao Tong University
Hong Kong Institute for Monetary Research

March 2014

Abstract

This paper develops and estimates a dynamic model of consumer demand for deposits in which banks provide differentiated products and product characteristics that evolve over time. Existing consumers are forward-looking and incur a fixed cost for switching banks, whereas incoming consumers are forward-looking but do not incur any cost for joining a bank. The main finding is that consumers prefer banks with more employees and branches. The switching cost is approximately 0.8% of the deposit's value, which leads the static model to bias the demand estimates. The dynamic model shows that the price elasticity over a long time horizon is substantially larger than the same elasticity over a short time horizon. Counterfactual experiments with a dynamic monopoly show that reducing the switching cost has a comparable competitive effect on bank pricing as a result of reducing the dominant position of the monopoly.

Keywords: Banks in China, Demand Estimation, Switching Cost

JEL Classification: G21, L10

* I am grateful to Marc Rysman for his guidance and support. In addition, I have benefited from conversations with Otto Toivanen and seminar participants at the Bank of Finland (BOFIT), Beijing University, the Chinese University of Hong Kong, the City University of Hong Kong, Clemson University, Fudan University, the Georgia Institute of Technology, the Helsinki Center of Economic Research (HECER), Hong Kong University of Science and Technology, Renmin University, Shanghai Jiao Tong University, Shanghai University of Finance and Economics, the University of Hong Kong, the 2009 conference of the Chinese Economic Association in North America, the 2009 meeting of the European Association for Research in Industrial Economics, the 2010 International Industrial Organization Conference and the 2010 World Congress of the Econometric Society. I also acknowledge the financial support from Hong Kong Institute for Monetary Research (HKIMR) and the National Natural Science Foundation of China (NSFC, Project No. 71301103). All of the remaining errors are my own.

** The School of Economics, Shanghai Jiao Tong University, Shanghai 200052, P.R. China; E-mail: chunyu.ho@sjtu.edu.cn

1. Introduction

Switching cost is shown to be a determinant for maintaining the long-term relationship between consumers and banks in the deposit market (Kiser, 2002).¹ This paper studies the market for deposit accounts in China and evaluates the effect of switching costs on consumers' bank choices and bank pricing. The model allows for the dynamic optimization of consumers who face a cost for switching between banks and accounts for product differentiation. Then, the pricing implication of the switching cost is derived given the estimated demand and switching cost.

Bank pricing has become a key issue for Chinese banks, as intermediation services play an increasingly important role for Chinese banks. In the early 2000s, only approximately 10% of the bank income in China was contributed by non-interest income, which was far below the corresponding figure (which was approximately 30-40%) for banks in Europe and the U.S. Since 2004, the Chinese government has reduced the interest rate margin by deregulating the deposit interest rate and requesting that banks raise the contribution of non-interest income to their total income. However, there has not been much discussion of bank pricing when consumers in the banking market face a switching cost. Supplying this discussion provides insights to practitioners for pricing their services and to policy makers for evaluating the competitiveness of bank pricing when consumers face different levels of switching cost.

These issues are also important because of the well-established contribution of financial development to economic growth (King and Levine, 1993).² Indeed, allocative efficiency in the deposit market plays a pivotal role in fostering the growth of the Chinese economy because banks provide a huge share of the capital financing that underpins China's growth. In 2005, Chinese banks intermediated approximately 72% of the capital in China, which is more than double the rate in the US and 1.5 times higher than the rate in other Asian countries (Farrell et al., 2006).³ Moreover, the rate of participation in the deposit market in China is relatively high among developing countries. More than 70% of urban households have bank accounts according to the Chinese Household Income Survey of 1995, and this rate is not much lower than the rate (89%) of the U.S. (Gustafsson et al., 2006; Kiser, 2002). This statistic suggests that it is important for the Chinese government to reform its banking sector by making it competitive and efficient.

¹ Using the 1999 Michigan Surveys of Consumers that covered 1500 distinct US households, Kiser (2002) reports that the median duration of the relationship of consumers with their primary bank is about 10 years and 32% of the American stay with their first bank for their entire lifetime. Kiser documents that the primary reason consumers give for staying with their current bank is the location of the bank offices and ATMs or the quality of the customer service, and the second-most-important reason is the cost of switching. The reasons for such costs are as follows: (1) redirecting ingoing and outgoing payments, (2) searching for new options in the market, and (3) facing monetary penalties for terminating the existing contract. Moreover, Allen et al. (2008) argue that the switching cost in the Canadian banking market is high, as the median duration with a bank is more than 20 years.

² The role of the financial sector in fostering growth includes savings mobilization, capital allocation, monitoring the use of funds and risk management.

³ Hao (2006) further suggests that the Chinese provinces with higher ratios of savings deposits to GDP experience greater economic growth, which implies that those deposit services that encourage saving have been crucial to economic growth in China.

Because consumers need to pay a cost to switch from their current bank to a different bank, consumers in the deposit market are less price-sensitive and more concerned with future changes in banks' attributes. If the switching cost exerts a significant effect on consumer choices, a static demand model may bias the estimates of price elasticity and the willingness to pay for bank attributes. These biases can potentially undermine the reliability of many important applications of demand estimates for markets with significant consumer switching costs, such as defining a relevant market for antitrust analysis and evaluating a new product.

Moreover, demand estimation is complicated by the fact that the market contains both existing and incoming consumers; this phenomenon is particularly notable in emerging markets with ongoing urbanization. For instance, as a part of the economic reform in China, a huge rural-urban migration within provinces has occurred among young workers since the 1990s. This migration leads more people to work in urban areas and to utilize banks to deposit and remit their money, which in turn increases the size of the deposit market. In particular, in 1994-2001, the average growth rate of the size of the deposit market across provinces was approximately 16%, and this growth was positively related to the change in the urban-to-total worker ratio.⁴ Because existing consumers are expected to be partially locked-in to their current banks, incoming consumers have smaller switching costs than existing consumers.⁵ This consumer heterogeneity motivates the development of a dynamic model to capture these features of deposit demand.

This paper develops and estimates a dynamic model of consumer demand for deposits in which banks provide differentiated products and products' characteristics evolve over time. The two types of forward-looking consumers, i.e., existing and incoming consumers, choose their banks based on the utilities they receive from using different banks' services. Whereas existing consumers choose which bank to use and when to switch because they incur a fixed cost for switching banks, incoming consumers do not pay any cost for entering the deposit market and choosing their banks.

The empirical approach adopted in this paper makes inferences about consumer preferences based on data from four state commercial banks in the deposits market across Chinese provinces from 1994 to 2001. The model identifies and estimates switching costs using the responses of market shares to past changes in bank attributes and socioeconomic conditions. This approach of estimating the switching costs only requires bank-level data, which is particularly useful when micro-level data on the transitions of individual consumers is not available to researchers.⁶ In addition, using the dynamic structural model, I compute the own-price and cross-price elasticities over short and long time

⁴ Using a panel regression with province-specific and time-specific effects, the empirical relationship is estimated as $\Delta \ln(\text{MarketSize})_{mt} = 0.26 \Delta \ln(\text{UrbanWorker}/\text{TotalWorker})_{mt} + \epsilon_{mt}$, where m indicates the province and t is the time. The coefficient is statistically significant at the 5% level.

⁵ Kiser (2002) documents that job-related and migration reasons account for approximately 50% of the bank switches in the U.S.

⁶ This approach to estimating switching costs is different from utilizing micro-level panel data of individual purchases. In that approach, switching costs are identified with the switching behavior of consumers' choices in response to price changes (Dube et al., 2009). Nonetheless, the present approach, which is based on market-level data, does not identify switching costs from state dependence.

horizons to examine the impact of the switching cost on price elasticity.

The main finding of this work is that consumers prefer banks with more branches and employees. The switching cost is approximately 0.8% of the deposit value, which is equivalent to 1.4% of the actual disposal income of a typical Chinese household. Because consumers adjust their bank choices gradually when changes in bank attributes such as branching occur, the static demand model does not accurately describe consumers' willingness to pay for bank attributes. Moreover, the own-price and cross-price elasticities are larger over a long time horizon than over a short time horizon, which suggests that the low price elasticity of service fees in the static demand model can be partially explained by the fixed cost incurred by switching banks.

Switching costs not only play a crucial role in determining consumer behavior, but they also affect bank decisions.⁷ Switching costs allow banks to reduce their service fees to attract consumers, and then, to earn service fees from consumers over an extended time period. To shed light on this issue, I perform counterfactual experiments to examine the effects of switching costs on the pricing decisions of a dynamic monopoly that faces the estimated dynamic demand.⁸ I show that reducing the switching cost has a comparable effect on bank pricing to reducing the dominant position of a monopoly.⁹

1.1 Literature Review

The recent empirical literature on demand estimation for banking services employs the static demand models suggested by Berry et al. (1995) to analyze consumer preferences with respect to various bank attributes.¹⁰ Despite the importance of switching costs in the deposit market, their effects on demand estimation have received little attention in the literature. To address this shortcoming, my work contributes a dynamic structural model of deposit demand to estimate the consumers' switching cost and examine its effects on their willingness to pay for bank attributes, the price elasticity of demand and bank pricing. Focusing on the deposit market also fills the gap in the literature on Chinese banking reforms, as many authors have commented on the failure of the loan market to improve allocative efficiency in the 1990s (e.g., Cull and Xu, 2000, 2003; Park and Sehart, 2001).

⁷ Klemperer (1995) argues that if consumers need to pay a fixed cost to switch products, then a firm faces a tradeoff between lowering prices to attract new customers and raising prices to extract rents from existing customers. Dube et al. (2009) extend this argument to the model with logit demand and imperfect lock-in.

⁸ I employ a monopoly model instead of an oligopoly model because there is no clear evidence that those four SCBs acted like oligopolists in the sample period. In fact, Ho (2012) analyzes the same dataset with static demand and supply models and shows that the oligopoly model cannot fit the bank-level data better than the joint-monopoly model. Because the oligopoly price is bounded above by the monopoly price, my counterfactual experiments provide a lower bound for price reduction due to the dynamic incentives.

⁹ This result echoes the evidence that the switching cost affects the deposit rate in the U.S. Sharpe (1997) and Hannan and Adams (2011) show that bank retail deposit interest rates are more competitive if switching costs exist and banks are competing for new depositors; these authors use the migration rate as an inverse measure of the switching cost and find that there is a positive relationship between migration and deposit rates.

¹⁰ Examples include Adam et al. (2007), Dick (2008), Ishii (2008), Knittel and Stango (2008) and Ho and Ishii (2011) for the U.S., Nakane et al. (2006) for Brazil, Molnar et al. (2007) for Hungary, Molnar (2008) for Finland, Ho (2010) for Hong Kong, and Ho (2012) for China.

Furthermore, this paper is related to the literature on estimating switching costs in banking markets with bank-level data. Shy (2002) employs the equilibrium pricing condition of a static oligopoly model with a homogenous product to estimate the switching cost for the Finnish deposit market. Kim et al. (2003) use a firm profit-maximization-model embedding with a transition probability of banks' market shares to estimate the switching cost for the Norwegian loan market.¹¹ My work differs from those studies in that it uses a dynamic consumer demand model with differentiated products to estimate the switching cost.

My work builds on the methodology proposed in Gowrisankaran and Rysman (2012) in which they develop a structural model of dynamic demand for durable goods. Because consumers incur switching costs as they change banks, their bank choices become forward-looking and resemble the purchase of a durable good. Therefore, I adopt these authors' demand model and computational method as the basis of my model for bank choices, but I modify several aspects of their model to incorporate some interesting features of the deposit market in China.¹² First, I incorporate a parameter to capture the switching cost or the state dependence of consumer choices, and I identify this parameter with the interaction between lagged changes in bank attributes and socioeconomic conditions. Second, I introduce consumer heterogeneity by modeling these two types of consumers: one type incurs a fixed cost in switching banks (existing consumers) and the other type can choose a bank without cost (new consumers). Third, the forecasting equations for the evolution of flow utility are more flexible. Finally, I develop a supply-side model to perform counterfactual experiments to examine the effects of the switching cost on bank pricing.

In work similar to my own, Shcherbakov (2009) estimates the consumer switching cost in the U.S. television industry. My demand model differs from his model by allowing new consumers to enter the deposit market without paying any cost. This feature of my model aims to capture the influx of new depositors due to economic growth and rural-urban migration in China. For the counterfactual experiment, I follow his work by developing a dynamic monopoly model to examine the effects of the switching cost on bank pricing, but I employ an alternative computational algorithm with cost-side information.

The remainder of the paper is organized as follows: Section 2 provides the institutional background of the Chinese banking industry, Section 3 describes the data and descriptive statistics, and Section 4 discusses the dynamic structural model. In addition, Section 5 presents the estimation procedures, Sections 6 and 7 report the empirical results and the effects of switching cost on demand elasticity and bank pricing, respectively, and Section 8 concludes.

¹¹ Their switching cost refers to building a bank-customer relationship with a new bank in the loan market.

¹² This methodology is also modified and applied in Zhao (2008), Shcherbakov (2009), Schiraldi (2011) and Lee (2013).

2. The Chinese Banking Industry

China has a two-tier banking system.¹³ The People's Bank of China (PBC) is the central bank of China and supervises the banking industry. There are several types of financial institutions, including state commercial banks (SCBs), joint-stock banks (JSBs), city commercial banks, and non-bank financial institutions. Non-bank financial institutions include trust and investment companies, rural credit cooperatives (RCCs), and urban credit cooperatives.

The deposit and loan markets are highly regulated, and the SCBs have occupied a large share of these two markets. There are four SCBs: the Agricultural Bank of China (ABC), the Bank of China (BOC), the China Construction Bank (CCB) and the Industrial and Commercial Bank of China (ICBC).¹⁴ These four banks specialized in different businesses when they were established, with the ABC managing the rural banking business, the BOC handling foreign transactions, the CCB handling the financing for construction activities, and the ICBC managing the urban banking business.

Although the four SCBs began with different objectives, their specialization diminished as reforms directed their responsibilities towards profit maximization.¹⁵ First, the SCBs expanded their branch networks in all Chinese provinces to obtain funding. Second, since the second stage of banking reform started in 1994, three policy banks, namely, the China Development Bank, the Export-Import Bank of China, and the Agricultural Development Bank of China, were set up to take over the role of government lending for those four SCBs.¹⁶ Third, reforms continued with the passing of the 1995 Commercial Banking Law, which placed responsibility for profitability and the assessment of credit worthiness on banks (see IMF, 1996). Finally, although the interest rate for lending was gradually deregulated in 1996, banks could only set their deposit rates at the official benchmark rate chosen by the PBC until 2004. However, the PBC maintains a positive interest rate that is spread between the benchmark rates of lending and depositing to provide subsidies to SCBs and encourage lending to state-owned enterprises (SOEs).

With regard to the market outcomes, Table 1 reports the average market shares of each bank in the deposit market across all of China's provinces. In 1994, the market shares of the ABC (19%) and the ICBC (31%) were larger than the shares of the other two banks. Over the sample period, the market shares of the BOC and the CCB increased by acquiring market share from the ABC and the ICBC.

¹³ In this section, I focus on the market structure of the deposit market. See Dobson and Kashyap (2006) and Allen et al. (2008) for a detailed discussion of the banking industry in China.

¹⁴ Whereas the BOC was established as a private bank in 1912, the ABC, CCB and ICBC were established in 1951, 1954, and 1984, respectively.

¹⁵ Based on a static model, I do not find that the own-price elasticities across banks are substantially different from each other when I allow the price coefficients to vary across banks. The results are available upon request.

¹⁶ In 1993, according to the Almanac of China Finance and Banking (1994), the State Council announced the second stage of banking reform in the "Decision on the Financial System". Thus, the first stage of the banking reform discussed here was from 1979 to 1993, and the second stage of this banking reform started in 1994.

Moreover, the SCBs only lost 5% (from 72% to 67%) of their market share to JSBs, who are their primary domestic competitors, from 1994 to 2001.¹⁷ Consumers seem to perceive significant differentiation between SCBs and outside goods in that there is not much variation in the total market share of SCBs over time.

Substantial changes in the bank attributes of service fees and the numbers of branches and employees occurred over the sample period. Table 1 indicates that the average branch density and employees per branch decreased over the sample period. The reductions in the branch density and the total number of branches were larger for the ABC and the ICBC than for the other two banks over the sample period. Similarly, the rise in the ATMs per branch were smaller for the ABC and the ICBC than for the other two banks over the sample period. The number of employees per branch increased for the ABC and decreased for the other banks. In addition, service fees were generally higher in 2001. Table 1 offers preliminary evidence that the changes in the market shares of the four SCBs are related to lower service quality and higher service fees.

3. Data

The empirical analysis is based on a novel dataset that combines the provincial banking and economic data with the balance-sheet information of banks. The sample includes 828 annual observations from 1994 to 2001 at the level of bank-market years. Appendix 1 reports more details of the dataset and descriptive statistics of the variables that are used in the empirical analysis.

3.1 Market Definition

SCBs provide deposit services in each provincial market in China.¹⁸ In 1997, Chongqing was redefined as a municipality. Hence, China had 30 provinces before 1997 and 31 thereafter.

The high transaction costs of placing deposits with a distant bank lead consumers to focus on bank choices in the local area.¹⁹ Nonetheless, my definition of a geographic market is broader than the definition that would be applied in other countries, such as the U.S.²⁰ This definition of a market at the provincial level is due to the limited availability of data that would allow the definition of markets at the city or county level. However, this wider definition of a market may underestimate the elasticities of consumers in response to product characteristics.

¹⁷ The market shares of JSBs in 1994 and 2001 were 7% and 12%, respectively. Moreover, foreign banks hold less than 1% of the market share. Source: the Almanac of China Finance and Banking.

¹⁸ The People's Republic of China administers 33 provincial-level divisions, which include 22 provinces, five autonomous regions, four municipalities, and two special administrative regions. I exclude the special administration regions Hong Kong and Macau due to their different economic structures.

¹⁹ Amel and Starr-McCluer (2002) report that people in the US tend to open deposit accounts with banks that are close to home.

²⁰ For example, Dick (2008) defines the US banking market at the MSA level.

3.2 Market Size and Market Share

I use the total provincial deposits in financial institutions to measure the market size of market m in year t , and this size is denoted H_{mt} . To compute the market shares, I divide the deposits of each SCB by the market size in each market year. Let q_{jmt} be the quantity of deposits held by bank j . Then, $S_{jmt} = q_{jmt}/H_{mt}$ is the market share of bank j .²¹ The outside good is defined as all financial institutions except for the four SCBs.

3.3 Prices

The service fee is computed as the ratio of income from commissions to total deposits. The income from commissions is obtained from income statements and the total deposits are obtained from the balance sheets.²² The service fee includes fees for transferring money between accounts, trading foreign currencies, managing assets and using bank cards. The average service fee is 0.14% and the benchmark rate of deposit is 1.9%. In other words, consumers pay approximately 7% of their deposit interest as service fees.²³

Admittedly, the price variable is imperfect because it cannot show the price variation over a range of services that are provided by banks. Similar to other studies on demand estimation for deposit services, the data on service fees come from financial reports that are aggregated across provinces at the bank level. Thus, the service fee of each bank does not vary across provinces (i.e., $p_{jmt} = p_{jt}$). Furthermore, the price variable depends not only on the level of fee that is charged but also on how actively customers use the bank services. I address this endogeneity issue of the price variable with instrumental variables (see Appendix 2 for details).

3.4 Observed Characteristics

I use two bank characteristics, namely, the numbers of branches and employees at the provincial level, to proxy the service quality provided by SCBs. Because the branch and employee data are available at the provincial level, those variables vary at the level of bank-market years. The observed characteristics include the number of employees per branch and the branch density (the ratio of the number of branches in a province to the area of the province in square kilometers). The branch density and employees per branch captures the convenience of banks' locations and the availability of employees at the branches, respectively. However, the latter measure cannot capture the efficiency of

²¹ Due to data limitations, the analysis cannot be further extended to different types of services such as demand and time deposits as in Nakane et al. (2006). Because province-level data is only available for the four SCBs, I cannot compare the demands of different types of financial institutions as Adams et al. (2007) did for the U.S.

²² The BOC's commission fee from 1994 to 1996 was included in the official figures with other income sources, such as non-operating income. To extract the commission income from the data, I use the ratio of the commission fees to other income in 1996, i.e., 0.2.

²³ All banks provide the same deposit rate to consumers in accordance with the benchmark rate set by the PBC. Therefore, the deposit rate is not used in the estimation, as time dummies are employed.

the workforce. Furthermore, I use two bank attributes that vary across bank-year observations but not across provinces. First, I sum the number of branches across all of China's provinces to obtain the total number of branches, which proxies for the size of the branch network that is provided to consumers. Second, I compute the number of ATMs per branch using the ratio of the total number of ATMs to the total number of branches for each bank. In addition, the choice of observed characteristics follows the literature to allow for comparison.

Finally, I include the following three control variables at the provincial level: the RCC density (the ratio of the number of RCCs per square kilometer in a province), the real GDP and the agricultural share of the GDP. The descriptive statistics for the RCC density, the real GDP and the agricultural share of the GDP suggest that it is important to control for market characteristics in the estimation. Because many banks only operate in a limited number of provinces, the market characteristics can also be used to proxy different sets of banks in each province.

4. Model

This section outlines the dynamic model of demand for deposit services. The model contains two types of forward-looking consumers, namely, existing and incoming consumers. Both of these groups are concerned about the product attributes provided by banks both now and in the future. Existing consumers incur a fixed cost by switching banks, whereas incoming consumers do not incur any cost by entering the deposit market. The following sub-sections focus on the dynamic decision problem of existing consumers, and incoming consumers represent a special case.

The demand system is based on the structural model of demand for differentiated products, which is related to the indirect utility provided by each bank based on its attributes. The bank attributes represent the service quality provided by banks, such as the convenience of local branches. The interest rate paid by SCBs is fixed by the central bank and does not vary across banks, which is in contrast to studies that use data from other countries. Consequently, my specification restricts the price competition among banks to service fees, which is different from other models used in the literature on deposit demand, such as Nakane et al. (2006) and Dick (2008). This institutional feature allows me to focus on one price variable in estimation and counterfactual experiments.

The market is defined as the deposit market in each Chinese province, and thus, the industry consists of four banks and M local markets. I index the provincial markets by m , the banks by j and the time by t . Note that I omit the market subscript m in this section to simplify the notation. Consumers with bank accounts use not only the deposit services but also other services provided to account holders, such as asset management, foreign currency trading and bank-card services. In a province, consumers choose to use deposit services from one of the banks, which include the ABC, BOC, CCB, ICBC and outside goods.²⁴ I index the ABC, BOC, CCB, ICBC and outside goods by a , b , c , d and o ,

²⁴ One reason for consumers to use one bank (or to have a main bank) is that consumers can exploit economies of scale and scope to reduce the time cost for using the bank's services.

respectively.

4.1 The Consumers' Problem

In each period, the existing consumers decide whether to stay with their current bank or switch to another bank. These consumers maximize the present discounted value of the expected utilities to make their decisions. For a consumer who stays with the same bank, the flow utility of consumer i who uses deposit services from bank j in market m at time t is as follows:

$$u_{ijt} = x_{jt} \beta_x - \alpha p_{jt} + \xi_{jt} + \varepsilon_{ijt} \equiv \delta_{jt}^f + \varepsilon_{ijt} \quad (1)$$

where p_{jt} is the service fee of bank j , x_{jt} is a K -dimensional row vector of the observed product characteristics of bank j , and ξ_{jt} represents the unobserved product characteristics of bank j . The consumer-specific preference is captured by a deviation specific to bank j in province m at time t , namely, ε_{ijt} . This deviation is assumed to be a mean zero stochastic term with an i.i.d. extreme-value Type 1 distribution. The $K+1$ dimensional vector $\theta = (\beta_x, \alpha)$ represents the demand parameters, where $\beta_x = (\beta_{x1}, \dots, \beta_{xK})$ is the set of parameters that associate the mean utility with the bank characteristics and α is the parameter associated with consumers' preferences with respect to service fees. Therefore, δ_{jt}^f is independent of the consumer characteristics, whereas ε_{ijt} represents the consumer characteristics. Moreover, the flow utility of using an outside good is normalized to zero, i.e., $\delta_{ot}^f = 0$.

4.2 The Bellman Equation

To evaluate a consumer's choice at time t , the expectation of consumer i about the future utility from bank services must be formulated. I assume that consumers have no information about the future values of the idiosyncratic shocks ε_{ijt} beyond their distributions. Prices and bank attributes vary across time due to technological progress, product innovation and changes in price. Although the consumers are uncertain about future bank attributes, they rationally expect these attributes to evolve based on the current market information. It follows that the discrete decision of consumer i to stay or switch depends on the following: the switching cost, τ ; idiosyncratic preferences, $\varepsilon_{i,t}$; and current realizations and future expectations of the bank attributes.

Let Ω_t be the set of information that is available to consumers in period t , this set is used to produce information about the future bank attributes as a function of the current market information. I assume that Ω_t evolves according to some Markov process $P(\Omega_{t+1}|\Omega_t)$. Let $\varepsilon_{i,t} \equiv (\varepsilon_{iat}, \varepsilon_{ibt}, \varepsilon_{ict}, \varepsilon_{idt}, \varepsilon_{iot})$ denote the set of idiosyncratic utility components for consumer i at period t . The value functions for current consumers who bank at the ABC, BOC, CCB, ICBC and outside goods are

$$\begin{aligned}
V_i(\varepsilon_{i\bullet t}, a, \Omega_t) &= \text{Max}(\delta_{at}^f + \varepsilon_{iat} + \beta E[V_i(\varepsilon_{i\bullet t+1}, a, \Omega_{t+1}) | \Omega_t], \dots, \\
&\quad \delta_{dt}^f + \varepsilon_{idt} + \beta E[V_i(\varepsilon_{i\bullet t+1}, d, \Omega_{t+1}) | \Omega_t] - \tau, \varepsilon_{iot} + \beta E[V_i(\varepsilon_{i\bullet t+1}, o, \Omega_{t+1}) | \Omega_t] - \tau) \\
&\quad \vdots \\
&\text{and} \\
V_i(\varepsilon_{i\bullet t}, o, \Omega_t) &= \text{Max}(\delta_{at}^f + \varepsilon_{iat} + \beta E[V_i(\varepsilon_{i\bullet t+1}, a, \Omega_{t+1}) | \Omega_t] - \tau, \dots, \\
&\quad \delta_{dt}^f + \varepsilon_{idt} + \beta E[V_i(\varepsilon_{i\bullet t+1}, d, \Omega_{t+1}) | \Omega_t] - \tau, \varepsilon_{iot} + \beta E[V_i(\varepsilon_{i\bullet t+1}, o, \Omega_{t+1}) | \Omega_t])
\end{aligned} \tag{2}$$

Following Rust (1987), I reduce the state in space that is related to the unobservables $\varepsilon_{i\bullet t}$ by integrating the value functions over the realizations of $\varepsilon_{i\bullet t}$. The integrated value function of the consumers of bank j is

$$EV(j, \Omega_t) = \log \left(e^{\delta_{jt}^f + \beta E[EV(j, \Omega_{t+1}) | \Omega_t]} + e^{-\tau} \sum_{k \neq j} e^{\delta_{kt}^f + \beta E[EV(k, \Omega_{t+1}) | \Omega_t]} \right) \tag{3}$$

for $j = \{a, b, c, d, o\}$. Using the assumption that $\delta_{ot}^f = 0$, the integrated value function for consumers who bank with the outside goods takes a simpler form, which is as follows:

$$EV(o, \Omega_t) = \log \left(e^{\beta E[EV(o, \Omega_{t+1}) | \Omega_t]} + e^{-\tau} \sum_{k \neq o} e^{\delta_{kt}^f + \beta E[EV(k, \Omega_{t+1}) | \Omega_t]} \right) \tag{4}$$

In the same vein as Gowrisankaran and Rysman (2012), I define the logit inclusive value of switching for a consumer with bank j at time t to be

$$\delta_{-jt} \equiv \delta_{-j}(\Omega_t) = \log \left(\sum_{k \neq j} e^{\delta_{kt}^f + \beta E[EV(k, \Omega_{t+1}) | \Omega_t]} \right) \tag{5}$$

I assume that the values of switching from the current bank to another bank are subsumed in a single scalar variable, namely, δ_{-jt} . Accordingly, the integrated value functions can be simplified to the following form:

$$EV(j, \Omega_t) = EV(\delta_{jt}^f, \delta_{-jt}, \Omega_t) = \log \left(e^{\delta_{jt}^f + \beta E[EV(\delta_{jt+1}^f, \delta_{-jt+1}, \Omega_{t+1}) | \delta_{jt}^f, \delta_{-jt}, \Omega_t]} + e^{-\tau} e^{\delta_{-jt}} \right) \quad (6)$$

$$EV(o, \Omega_t) = EV(\delta_{-ot}, \Omega_t) = \log \left(e^{\beta E[EV(\delta_{-ot+1}, \Omega_{t+1}) | \delta_{-ot}, \Omega_t]} + e^{-\tau} e^{\delta_{-ot}} \right)$$

Equation (6) indicates that the integrated value functions are symmetric for consumers in bank $j=\{a,b,c,d\}$, except that the expectation processes are different for each flow utility and inclusive value. Following the assumption of inclusive value sufficiency (IVS) in Gowrisankaran and Rysman (2012), I assume that consumers only use the flow utility and the logit inclusive value rather than the entire state space Ω_t to predict the future integrated value functions, i.e., I assume that

$$\begin{aligned} E[EV(\delta_{jt+1}^f, \delta_{-jt+1}, \Omega_{t+1}) | \delta_{jt}^f, \delta_{-jt}, \Omega_t] &= E[EV(\delta_{jt+1}^f, \delta_{-jt+1}) | \delta_{jt}^f, \delta_{-jt}] \\ E[EV(\delta_{-ot+1}, \Omega_{t+1}) | \delta_{-ot}, \Omega_t] &= E[EV(\delta_{-ot+1}) | \delta_{-ot}] \end{aligned} \quad (7)$$

where $j=\{a,b,c,d\}$. Although this assumption reduces the computational burden of the dynamic optimization problem, it also imposes some restrictions on consumer behavior by assuming that consumers respond to the flow utility and the logit inclusive value rather than the bank attributes. For example, the flow utility δ_{dt}^f can be large because the service fee of the ICBC is low or because the branch density of that bank is high. These two situations provide the same information to consumers for predicting the future value functions.

To solve the consumer decision problem, I assume that consumers have rational expectations about the stochastic process that governs the evolution of the future value δ_{jt}^f for $j=\{a,b,c,d\}$ and δ_{-jt} for $j=\{a,b,c,d,o\}$. In practice, I specify consumers' expectations of $P(\delta_{jt+1}^f | \delta_{jt}^f)$ and $P(\delta_{-jt+1} | \delta_{-jt})$ using the linear forecasting rules

$$\begin{aligned} \delta_{jt}^f &= \gamma_{j11} + \gamma_{j12} \delta_{jt-1}^f + \sigma_{j1} e_t \\ \delta_{-jt} &= \gamma_{j21} + \gamma_{j22} \delta_{-jt-1} + \sigma_{j2} e_t \end{aligned} \quad (8)$$

where $\{\gamma_{j11}, \gamma_{j12}, \sigma_{j1}\}_{j=\{a,b,c,d\}}$ and $\{\gamma_{j21}, \gamma_{j22}, \sigma_{j2}\}_{j=\{a,b,c,d,o\}}$ are the parameters to be estimated. The error term

e_t follows the standard normal distribution.

The consumer problem can be illustrated with the following scenario over two periods: in period t , consumers select one of the banks and observe both the flow utility provided by each bank and the preference shocks for each bank. Then, these consumers form expectations of how the flow utility of their current banks and rival banks will evolve in the future and compute the discounted sum of the expected utility that will be provided by each bank. Finally, consumers choose one of the banks in the market (by staying or switching). If a consumer switches from one bank to another bank, a switching cost τ is incurred. This switching cost is interpreted as the opportunity cost that is incurred when consumers switch from one bank to another bank. In period $t+1$, consumers return to the market with the bank they chose in period t . However, consumers observe that the bank attributes differ from those provided in period t , but the changes are exogenous (with the exception that service fees can correlate with unobserved bank characteristics). Given the provided flow utility and the preference shocks of each bank in period $t+1$, consumers repeat the process of forming expectations and choosing a bank.

4.3 Computing the Market Shares

Because there are two types of consumers, market shares are determined by the choices made by both existing and incoming consumers. For existing consumers, the probability of staying or switching is determined by the solution to the dynamic optimization problem of consumers. The switching probabilities of consumer i with bank $j \neq k$ is

$$\begin{aligned}
 P(j \rightarrow k) &= [1 - P(j \rightarrow j)]P(j \rightarrow k | \text{Switch}) \\
 &= \left(1 - \frac{e^{\delta_{jt}}}{e^{\delta_{jt}} + e^{\delta_{-jt} - \tau}} \right) \frac{e^{\delta_{kt} - \tau}}{e^{\delta_{-jt} - \tau}} \\
 &= \frac{e^{\delta_{kt} - \tau}}{e^{\delta_{jt}} + e^{\delta_{-jt} - \tau}}
 \end{aligned} \tag{9}$$

where $\delta_{jt} = \delta_{jt}^f + \beta E[EV(\delta_{jt+1}^f, \delta_{-jt+1}) | \delta_{jt}^f, \delta_{-jt}]$ for $j=\{a,b,c,d\}$. For the incoming consumers, they are forward-looking but do not pay a fixed cost for choosing their first bank. The probability that consumer i will choose bank j is

$$P(j) = \frac{e^{\delta_{jt}}}{\sum_{k=\{a,b,c,d,o\}} e^{\delta_{kt}}} \tag{10}$$

The choice of incoming consumers depends on the future values of each bank because they may switch bank in the future. Therefore, the choice of incoming consumers exhibits the same form as the existing consumers except that the parameter τ is set to zero. I compute the market share of each bank $j=\{a,b,c,d,o\}$ as follows:

$$s_{j,t+1} = \lambda \left[s_{jt} P(j \rightarrow j) + \sum_{k \neq j} s_{kt} P(k \rightarrow j) \right] + (1 - \lambda) P(j) \quad (11)$$

The market share of a bank among existing consumers in the following period is the total number of consumers who stay with the same bank and consumers who switch from other banks. I define the parameter λ as the fraction of consumers who are already in the market, and therefore, the parameter $1-\lambda$ captures the fraction of incoming consumers in the next period. As a result, the total market share of a bank in the following period is the weighted sum of the market shares of the existing and incoming consumers.

4.4 Price Elasticity

As shown in the literature, the demand elasticity with respect to service fees is low. One possible explanation is that consumers incur a cost by switching banks, which creates rigidity in their choices. The existing consumers determine their switching decisions by a trade-off between the expected sum of the benefits and the switching cost. If an increase in the flow utility increases the difference of the expected discounted sum of future payoffs, the consumers may switch to another bank if the benefit outweighs the switching cost. Furthermore, existing consumers may decide to switch to another bank in the future instead of now because of their idiosyncratic preference shocks.

To illustrate these features of consumer choices, I examine the permanent price elasticity over two different time horizons in which the price change is believed to be permanent. First, I consider the permanent price elasticity in the short run, which is the percentage change of the market share in the next period in response to a permanent one-percent change in the service fees. The short-run own-price elasticity of the dynamic model for bank j is

$$\frac{\partial s_{j,t+1}}{\partial p_{jt}} \frac{p_{jt}}{s_{jt}} = -\lambda \alpha \frac{p_{jt}}{s_{jt}} \left(\sum_{k=\{a,b,c,d,o\}} s_{kt} P(k \rightarrow j) [1 - P(k \rightarrow j)] \right) \frac{\partial \delta_{jt}}{\partial \delta_{jt}^f} - (1 - \lambda) \alpha p_{jt} [1 - P(j)] \frac{\partial \delta_{jt}}{\partial \delta_{jt}^f} \quad (12)$$

Similarly, the short-run cross-price elasticity for bank j is

$$\frac{\partial s_{jt+1}}{\partial p_{jt}} \frac{p_{jt}}{s_{jt}} = \lambda \alpha \frac{p_{jt}}{s_{jt}} \left(\sum_{k=\{a,b,c,d,o\}} s_{kt} P(k \rightarrow j) P(k \rightarrow l) \right) \frac{\partial \delta_{jt}}{\partial \delta_{jt}^f} + (1-\lambda) \alpha p_{jt} P(j) \frac{\partial \delta_{jt}}{\partial \delta_{jt}^f} \quad (13)$$

where $\neq k$. In my model, the price elasticity is a weighted average of the elasticities of the existing and incoming consumers. In particular, the price elasticity of incoming consumers does not depend on the current market share. Second, for a given combination of $(\tau, \delta_{at}^f, \delta_{bt}^f, \delta_{ct}^f, \delta_{dt}^f)$, I compute the steady-state market share of each bank: $s_{jt}^* = S_j(\tau, \delta_{at}^f, \delta_{bt}^f, \delta_{ct}^f, \delta_{dt}^f)$.

Proposition: Using the law of motion (11) with $\lambda=1$, the market share of each bank $j=\{a,b,c,d,o\}$ at a steady state is given by $s_{jt}^ = S_j(\tau, \delta_a^f, \delta_b^f, \delta_c^f, \delta_d^f)$ for $j=\{a,b,c,d,o\}$. Proof: See Appendix 3.*

Here, I consider the permanent price elasticity in the long run, which is the percentage change of the steady-state market share due to a permanent one-percent change in the service fees. Hence, the long-run own-price and cross-price elasticities for the existing consumers are

$$\frac{\partial s_{jt}^*}{\partial p_{jt}} \frac{p_{jt}}{s_{jt}^*} = -\alpha \frac{p_{jt}}{s_{jt}^*} \frac{\partial S_j(\tau, \delta_{at}^f, \delta_{bt}^f, \delta_{ct}^f, \delta_{dt}^f)}{\partial \delta_{jt}^f} \quad \text{and} \quad \frac{\partial s_{jt}^*}{\partial p_{kt}} \frac{p_{kt}}{s_{jt}^*} = \alpha \frac{p_{kt}}{s_{jt}^*} \frac{\partial S_j(\tau, \delta_{at}^f, \delta_{bt}^f, \delta_{ct}^f, \delta_{dt}^f)}{\partial \delta_{kt}^f},$$

respectively. In contrast, the incoming consumers only need to determine their choices when they enter the market. Therefore, their long-run own-price and cross-price elasticities take on the form of the short-run price elasticity. Consequently, the long-run own-price and cross-price elasticities are the weighted averages of the elasticities of the existing and incoming consumers.

5. Estimation

This section specifies the parametric forms for the demand system and outlines the procedures used in the estimation. The main task of the demand estimation is to obtain the flow utility of the bank services that are provided to consumers, which is then used to recover the consumer preferences with respect to the bank attributes and the switching cost. Two model parameters are calibrated with prior information rather than estimated from this procedure. First, as Magnac and Thesmar (2002) argue that the discount factor is difficult to estimate in a dynamic decision model, I do not estimate the discount factor and I set $\beta = 0.95$. Second, I set the parameter $\lambda = 0.86$ because the deposit market grows at a rate of 16%, which indicates that approximately 86% ($=1/1.16$) of customers are existing consumers.²⁵

²⁵ A limitation of this approach is that it treats the expansion of the deposit market as solely derived from incoming customers and ignores the increase in deposit amount per customer as a factor of market expansion. Although this assumption may underestimate the fraction of existing consumers, it does not affect the result that the elasticity of the dynamic model is larger than the elasticity of the static model because the elasticity of the dynamic model increases in accordance with the fraction of existing consumers.

Following Gowrisankaran and Rysman (2012), the estimation algorithm has three levels of non-linear optimization. The outer loop is a non-linear search over the parameters of the model with a fixed-point calculation of the flow utility δ_{jmt}^f for $j = \{a, b, c, d\}$ nested inside. In the middle loop, for the fixed-point calculation, the predicted market share of each bank is computed as the solution to the dynamic optimization problem of consumers in the inner loop.²⁶

5.1 The Inner Loop

I discretize δ_{jmt}^f to solve for $EV(\delta_{jmt}^f, \delta_{-jmt})$ and $EV(\delta_{-omt})$ according to equation (6). More specifically, I estimate the AR(1) processes (8) to obtain the parameters $\{Y_{j11}, Y_{j12}\}_{j=\{a,b,c,d\}}$ and $\{Y_{j21}, Y_{j22}\}_{j=\{a,b,c,d,o\}}$. Then, I use these estimates and standard errors to calculate the transition matrix for computing the fixed points of the value functions (6). Then, I compute the probability of switching and the market share as solutions of the dynamic optimization of consumers given vectors of $\{\delta_{jmt}^f\}_{j=\{a,\dots,d\}}$ and τ .

5.2 The Middle Loop

For the middle loop of the estimation, the value for the estimated unobserved product characteristics, or $\xi(\tau)$, is obtained once the flow utility is computed using the contraction mapping proposed by Berry et al. (1995). Recall that the flow utility is postulated as follows:

$$\delta_{jmt}^f = x_{jmt}\beta_x - \alpha p_{jt} + \xi_{jmt} \equiv x_{jmt}\beta_x - \alpha p_{jt} + \zeta_m + \zeta_t + \zeta_j + \zeta_{jmt} \quad (14)$$

where β_x and α are the parameters to be estimated. The vector of the exogenous bank characteristics and demographic variables x_{jmt} is

$$x_{jmt} \equiv (Employee/Branch_{jmt}, Branch Density_{jmt}, Total Branches_{jt}, ATM/Branch_{jt}, RCC Density_{mt}, RGDP_{mt}, Agricultural Share in GDP_{mt}) \quad (15)$$

I decompose the unobserved product characteristics into four terms, where ζ_m is a dummy variable that captures the time-invariant fixed-market effect; ζ_t is a dummy variable that captures the fixed-year effect; ζ_j is a dummy variable that captures the time-invariant utility value of the BOC, the CCB and the ICBC relative to the same value of the ABC; lastly, ζ_{jmt} represents the bank-market-year

²⁶ The initial guess for the flow utility is obtained by using the static model in which there is no switching cost, i.e., where $\tau=0$.

unobserved product characteristics. Furthermore, I treat the service fees as an endogenous variable and use the two-stage least-squares (2SLS) estimation procedure to estimate equation (14). See Appendix 2 for the details of the instrumental variables.

5.3 The Outer Loop

This step constructs the set of moments m by interacting a vector of lagged explanatory variables w_{jmt-1} with the unobserved product characteristics ζ_{jmt} to identify the consumer switching costs. The lagged bank attributes and socioeconomic variables are exogenous and independent of the error terms in the demand equation. Therefore, w_{jmt-1} is orthogonal to ζ_{jmt} , i.e., $E(w'_{jmt-1}\zeta_{jmt}) = 0$. Particularly, the following 14 variables are in w_{jmt-1} : the Branch Density, the Total Branches, ATMs/Branch, the RCC Density, RGDP, the Agricultural Share in GDP, four interaction terms between the first four variables and RGDP, and four interaction terms between the first four variables and the Agricultural Share in GDP.

The GMM estimator given my moment conditions is defined as $\text{Min}_\tau m'\Omega m$, where Ω is the optimal weighting matrix. The parameter τ is identified based on the information concerning the switching behavior in response to past changes in the bank attributes and socioeconomic variables.²⁷ If the switching cost is zero, any change in the bank attributes and socioeconomic variables should instantly affect the market share. In contrast, a positive switching cost delays the adjustment of the market share. Therefore, the past bank attributes and socioeconomic variables can be used to construct moment conditions that identify the switching costs. A limitation of this identification strategy is that it assumes that past changes in product attributes and socioeconomic variables are orthogonal to the switching cost. This approach also stipulates that consumer characteristics determine the switching cost, which precludes the situation that banks internalize the switching cost as an equilibrium response to their changes in attributes.

6. Empirical Results

This section discusses the empirical results obtained from the dynamic model described in the previous section. The main results are reported in the column *Dynamic-1* in Table 2. This is followed by the analysis of the consumer preferences and the process of expectation formation regarding the bank attributes.

A note of caveat should be mentioned before discussing the results. Because the product that is set in the bank-province-level dataset is invariant across markets and over time, and because there are always four state commercial banks and an outside good, the identification of the random coefficient

²⁷ However, I do not include the lagged market share in the variable w_{jmt-1} because it does not contain the necessary information for identifying the switching cost. Consider the situation that the market shares of the four banks remain unchanged over two years. This lack of change indicates two possible switching behaviors, which are as follows: (1) there is no movement of consumers among those banks. (2) There is significant movement of consumers among the banks, but this movement does not change the resulting market shares over two consecutive periods.

is impossible.^{28, 29} Inasmuch as my model does not include the random coefficient for consumer preferences, my results must be interpreted with the caveats that the logit model suffers from the problem of the independence of irrelevant alternatives (IIA) and does not allow for persistent heterogeneity in consumer preferences.

Table 2 reports that the coefficients for the branch density and the total number of branches are positive and significant in the dynamic model, which indicates that SCBs can attract more consumers by expanding the branch network. The positive coefficient for employees per branch suggests that consumers prefer a bank with a higher ratio of employees to branches. However, the coefficient of ATMs per branch is statistically insignificant. Due to the differences in the scale of each variable, the parameter estimates are not directly comparable. To demonstrate the importance of various bank characteristics to consumer choices, I compare the impacts of these characteristics on the utility by increasing each characteristic one standard deviation above its mean and computing the consumers' willingness to pay in exchange for these improvements in service quality. The results are presented in column *WTP-1* of Table 2.

The willingness to pay for employees per branch, the branch density and the total number of branches expressed in terms of the deposit value are 0.02%, 0.04% and 0.11%, respectively, in the dynamic model.³⁰ The magnitudes of the willingness to pay for these hypothetical changes are significant and range from 14% to 77% of the average annual service fee.³¹ Comparing the results from the static and dynamic models, whereas the static model overstates the consumers' willingness to pay for a high branch density, it underestimates their willingness to pay for extra employees per branch, total number of branches and ATMs per branch.

The empirical results indicate that in addition to prices (i.e., service fees), service quality is another effective way to attract consumers. The demand estimates suggest that consumers respond to branch expansion more than they respond to increases in the number of employees. Chinese consumers have stronger preferences with respect to branches than employees, which are similar to the preferences in the U.S. that were reported by Dick (2008). The economic development in China is skewed towards the provinces in coastal regions, and the job opportunities in those provinces are better than the opportunities in other provinces. As a result, migrant workers commonly move from less-developed inland provinces to more developed coastal regions to seek work. A portion of their income is frequently remitted back to their family in their province of origin, and this transaction can be

²⁸ In practice, I experimented with various static demand models to examine whether the data contain sufficient information to identify the random coefficient. I estimated a static logit demand model as a benchmark case and a static demand model with random coefficients for the intercept and price variable, where the random coefficient of the intercept is insignificant and the price coefficient with a random coefficient is close to the same coefficient from the logit model. Moreover, there is not much change in the price elasticity. These results are available upon request.

²⁹ The insignificant estimates on the random coefficients are also observed in Shcherbakov (2009), where the product set is also invariant across markets and over time.

³⁰ I focus on those bank attributes that have coefficients estimated with statistical significance at the 10% level.

³¹ The average service fee is 0.15% of deposits.

facilitated by a larger branch network.

The demographic variables indicate that the demand for SCBs in a province depends on economic development: market shares of SCBs are higher in provinces with a higher real GDP. SCBs enjoy higher market shares in rich provinces, as they are able to provide a wider range of banking services to wealthy consumers than small or medium-sized banks. However, the coefficients of the RCC density and of the agricultural share of GDP are not significant at conventional levels in the dynamic model.

Finally, I report the estimation results of forecasting equation (8) in Table 3-1. All of the coefficients for the intercept and lagged flow utility are statistically significant at the 5% level. The coefficients of the lagged flow utilities range from 0.56 to 0.60, which suggests that consumers' expectations for changes in service quality are persistent. Similarly, the processes of logit inclusive values of rival banks are persistent, and the coefficient of the lagged dependent variable ranges from 0.46 to 0.52. This finding suggests that the consumer problem of bank choice is dynamic instead of static.

Following Gowrisankaran and Rysman (2012), I compute the correlation between the contemporaneous errors and the lag prediction errors to verify the empirical validity of the IVS assumption. Table 3-1 reports that the correlations are negative and statistically significant at the 5% level, which casts doubt on the empirical validity of the IVS assumption. Therefore, I perform a robustness check by including the second-order autoregressive term as an additional variable that consumers use to predict the future realization of the flow utility and the inclusive value. The results of the forecasting equations are reported in Table 3-2, and those results that correspond to the demand parameters and WTPs are reported under the columns *Dynamic-2* and *WTP-2* in Table 2, respectively. Table 3-2 reports that the correlations between the contemporaneous errors and the lag prediction errors become much weaker. Because almost all of these correlations do not show statistical significance at any conventional level, this result supports the IVS assumption in this model. Moreover, Table 2 reports that the results of this model (see *Dynamic-2* and *WTP-2*) are close to those of the base model (see *Dynamic-1* and *WTP-1*). Hence, it does not appear that the results of the demand parameters and WTPs hinge on the specifications of expectations.

7. Switching Cost and its Implications

The coefficient of the switching cost is positive and significant, which indicates that consumers incur an opportunity cost by switching banks. This cost inhibits consumer responsiveness to changes in bank characteristics and service fees. To quantify the switching cost, it is useful to compare the relative impact of service fees and the switching cost on consumer utility. The switching cost is equivalent to 0.8% of the deposit value, which is larger than the average annual service fee (0.14%).³²

³² A one-unit increase in service fees implies an increase in service fees from the current rate to the current rate plus the whole deposit amount. This dramatic change reduces the utility value by 192 units. Therefore, the monetary value of the switching cost is computed as 1.50/192 in the dynamic model.

Using the per capita deposit in urban areas in 1994, which was RMB \$4,870 (US \$696), the monetary value of the switching cost was RMB \$39 (US \$6). The switching cost has a considerable impact on a consumer's bank choice because the cost is approximately 1.1% of the annual disposable income of a typical household, i.e., RMB \$3,496 (US \$499) in 1994.³⁴ The high percentage of the switching cost in terms of income is due to the high savings rate of Chinese households. Consequently, a temporary (one-period) change in service fees or service quality does not lead to a significant change in the market shares of banks because the monetary incentive created by the change in price or quality is not large enough to compensate consumers for the cost incurred by switching banks.

7.1 Price Elasticity

Panel A of Table 4 reports the short-run demand elasticities with respect to the service fees, whereas Panel B of Table 4 shows that the long-run price elasticity is larger than the short-run price elasticity. The long-run own-price elasticity suggests that the service fees set by the SCBs are closer to the elastic portion of the deposit demand, which is more consistent with profit maximization. To a lesser extent, the long-run cross-price elasticity is slightly larger than its short-run counterpart.

Although the switching cost makes banks less substitutable in the short run, the dynamic effect from the expected value function increases the substitutability over a longer time horizon. Consumers may delay their decisions in switching banks because they prefer to make their decisions later, when they have stronger preferences. This delay suggests that the short-run demand elasticity with respect to the service fees does not fully reflect the forward-looking behavior of consumers.

To infer the effect of the switching cost on consumer behavior, I use the difference between existing and incoming consumers in the model with a non-trivial switching cost because in that model, both types of forward-looking consumers share the same set of demand parameters. Table 5 shows that the short-run price elasticity of incoming consumers is larger than the same elasticity of existing consumers, which indicates that incoming consumers, who do not face switching costs, have more elastic short-run demand than existing consumers, who do incur switching costs. In other words, the switching cost deters existing consumers from changing banks.

Furthermore, to understand how the switching costs affect the demand parameters, I estimate the demand model on the assumption that no consumers incur any costs in switching banks. If consumers incur no switching costs for now and in the future, they become myopic in their bank

³³ Shy (2002) and Kim et al. (2003) report that the switching costs in the Finnish deposit market and the Norwegian loan market are about 0-11% of the deposit market and 4% of the loan market, respectively.

³⁴ Whereas the deposit per capita in rural areas in 1994 was RMB \$563 (US \$80), the monetary value of the switching cost was RMB \$4.5 (US \$0.6). This finding represents approximately 0.4% of the annual disposal income of a rural household, i.e., RMB \$1,221 (US \$174).

choices. More specially, no switching costs is equivalent to $\tau=0$ in Equation (6). In this case, the future values will be the same regardless of the current choice of bank, so these future values simply cancel out in the bank choices. As a results, the dynamic demand model collapses to the static demand model, thus their bank choice probability has the typical logit form. Table 2 reports the estimates of the static demand model for the myopic consumers in the column *Myopia* (see Appendix 2 for details), and Table 6 reports the corresponding price elasticities. The price elasticities of myopic consumers are even smaller than the short-run price elasticities reported in Table 4. These findings suggest that the switching cost is an important determinant for shaping consumers' bank choices and generating larger price elasticities.

7.2 Bank Pricing

This sub-section develops a dynamic monopoly model together with the estimated dynamic demand model to analyze the effects of the switching cost on bank pricing in an equilibrium setting. This model also considers the distortion of the interest rate subsidy, which depresses service fees by reducing the marginal cost of SCBs.³⁵ In addition, this subsidy helps the dynamic monopoly model to rationalize an empirical result that features an inelastic demand in equilibrium. The dynamic monopoly model consists of two parts: the monopoly bank sets service fees to maximize its expected discounted sum of profit, and consumers maximize their expected discounted sum of the flow utilities and pay a fixed cost to switch between the monopoly bank and the outside goods. Following the demand model used in the previous sections, consumers enjoy flow utility if they deposit their money in the monopoly bank.³⁶

$$u_{imt} = x\beta_x - \alpha p_{mt} + \xi + \varepsilon_{imt} \equiv d - \alpha p_{mt} + \varepsilon_{imt} \equiv \delta_{mt}^f + \varepsilon_{imt} .$$

The variable d captures the net flow utility of service fees, which is assumed to be constant to simplify the model and draw attention to the pricing decision. I assume that ε_{imt} follows an extreme-value distribution and that the flow utility of outside goods is normalized to zero. The value function for consumers who stay with the monopoly bank at the end of the last period and the corresponding function for consumers who stay with the outside goods at the end of the last period are as follows:

$$V_i(\varepsilon_{i\bullet t}, m, \Omega_t) = \text{Max} \left(\delta_{mt}^f + \varepsilon_{imt} + \beta E[V_i(\varepsilon_{i\bullet t+1}, m, \Omega_{t+1}) | \Omega_t], -\tau + \varepsilon_{iot} + \beta E[V_i(\varepsilon_{i\bullet t+1}, o, \Omega_{t+1}) | \Omega_t] \right)$$

$$V_i(\varepsilon_{i\bullet t}, o, \Omega_t) = \text{Max} \left(\delta_{mt}^f - \tau + \varepsilon_{imt} + \beta E[V_i(\varepsilon_{i\bullet t+1}, m, \Omega_{t+1}) | \Omega_t], \varepsilon_{iot} + \beta E[V_i(\varepsilon_{i\bullet t+1}, o, \Omega_{t+1}) | \Omega_t] \right)$$

³⁵ In the sample period, the lending rate was set by the government to be above the deposit rate. Therefore, banks tried to earn more profit by attracting a large volume of deposits that could be used to earn profit in the loan market.

³⁶ I use the index m for the monopoly bank in this sub-section, and I use the index m for market in the Estimation section.

I integrate the value functions over the idiosyncratic shocks to obtain the integrated value functions for consumers who are affiliated with the monopoly bank and the outside goods. Because there are only two choices, I focus on the difference between the integrated value functions, i.e., on $\Delta EV(\Omega_t) = EV(m, \Omega_t) - EV(o, \Omega_t)$:

$$\Delta EV(\Omega_t) = \log \left(\frac{e^{\delta_{mt}^f + \beta E[\Delta EV(\Omega_{t+1})|\Omega_t]} + e^{-\tau}}{e^{\delta_{mt}^f - \tau + \beta E[\Delta EV(\Omega_{t+1})|\Omega_t]} + 1} \right) \Rightarrow \Delta EV(\delta_{mt}^f) = \log \left(\frac{e^{\delta_{mt}^f + \beta E[\Delta EV(\delta_{mt+1}^f)|\delta_{mt}^f]} + e^{-\tau}}{e^{\delta_{mt}^f - \tau + \beta E[\Delta EV(\delta_{mt+1}^f)|\delta_{mt}^f]} + 1} \right) \quad (16)$$

Following the assumption of IVS, I obtain the second expression in the above equation by assuming that consumers only use the flow utility δ_{mt}^f and not the entire state space Ω_t to predict the future integrated value functions. Furthermore, I assume that consumers have rational expectations about the stochastic process that governs the evolution of flow utility. In practice, I specify the consumer expectations with the linear forecasting rule $\delta_{mt}^f = \gamma_{m1} + \gamma_{m2}\delta_{mt-1}^f + \sigma_m e_t$, where the error term e_t follows the standard normal distribution.

The solutions of the consumer problem are the switching probability from the monopoly bank to the outside goods and the switching probability from the outside goods to the monopoly bank, which are as follows:

$$P(m \rightarrow o) = \frac{e^{-\tau}}{e^{\delta_{mt}^f + \beta E[\Delta EV(\delta_{mt+1}^f)|\delta_{mt}^f]} + e^{-\tau}} \quad \text{and} \quad P(o \rightarrow m) = \frac{e^{\delta_{mt}^f - \tau + \beta E[\Delta EV(\delta_{mt+1}^f)|\delta_{mt}^f]}}{e^{\delta_{mt}^f - \tau + \beta E[\Delta EV(\delta_{mt+1}^f)|\delta_{mt}^f]} + 1}$$

Moreover, the probabilities that incoming consumers choose the monopoly bank or the outside goods are $P(o \rightarrow m)$ or $P(m \rightarrow o)$ with $\tau = 0$, respectively. Therefore, the market share of the monopoly bank is computed by

$$\begin{aligned} S_m(s_{mt-1}, \delta_{mt}^f; \tau) &= S_m(s_{mt-1}, p_{mt}; \tau, d) \\ &= \lambda [s_{mt-1} P(m \rightarrow m) + (1 - s_{mt-1}) P(o \rightarrow m)] + (1 - \lambda) P(m) \end{aligned} \quad (17)$$

The main implication of consumer switching costs on the monopoly bank is that its objective function becomes forward-looking as follows:

$$W(s_{mt-1}) = \text{Max}_{p_{mt}} (\Pi(s_{mt-1}, p_{mt}; \tau, d, c) + \beta W(s_{mt}))$$

$$\text{where } \Pi(s_{mt-1}, p_{mt}; \tau, d, c) = (p_{mt} - c)S_m(s_{mt-1}, p_{mt}; \tau, d)$$

The current profit is represented by the function $\Pi(\bullet)$. The monopoly bank chooses the price to maximize the discounted sum of profit, where the initial market share is a state variable. The lower initial market share can be thought of as the scenario in which the monopoly faces stronger competition from the outside option. The timing of the decisions occurs as follows: the monopolist observes the state variable s_{mt-1} and learns the parameters d and c before it chooses a price, and then, consumers make their choices. There is a trade-off in this problem: although high prices can be used to exploit existing consumers, they reduce the future number of consumers and future profits.

Four sets of parameters must be calibrated for the dynamic monopoly model. First, I use the estimates reported in the column *Dynamic-1* of Table 2 to calibrate the parameters α and τ of the consumer preferences. Second, the net flow utility of service fees, d , is a parameter for the monopoly bank. I calibrate this parameter to its sample average, i.e., to -0.014.

Third, I incorporate the lending side of the bank into my model by allowing the interest-rate subsidy to reduce the marginal cost of the monopoly bank. The bank is viewed as a production process for deposits and loans in which there are three inputs for this production, namely funding, employees and fixed assets. Following the banking literature, I use the interest expense to measure the cost of funding, and I use the operating expense to measure the cost of employees and fixed assets.³⁷ The operating expense is adjusted to 40% of its original value because 1) the ratio of deposits to total assets is 0.8 and 2) the deposit and lending services are assumed to consume equal operating resources. I sum the interest expenses and the adjusted operating expenses to obtain the total cost. Next, I calibrate the effective marginal cost of the monopoly bank with the ratio of the total cost to the deposits (i.e., 2.84%), and then, I adjust this cost downwards by the difference between regulatory lending and the deposit rates, i.e., by 3.37%. As a result, the marginal cost parameter c is set to -0.53% of the deposits' total value.

Finally, following Gowrisankaran and Rysman (2012), I estimate the parameters for the evolution of flow utility $\{\gamma_{m1}, \gamma_{m2}, \sigma_m\}$ to $\{0.09, 0.38, 0.05\}$ with a six-step iterative procedure: 1) I start with an initial guess of the sequence of flow utility δ_{mt}^f . 2) Then, I estimate the parameters $\{\gamma_{m1}, \gamma_{m2}, \sigma_m\}$ by OLS and use them to compute the value function according to Equation (16). 3) I solve for the consumers' decision rules and use this result to compute the market shares from the model according to Equation (17). 4) I equalize the predicted market shares to the observed total market shares of the four SCBs to solve for a new sequence of flow utility. 5) I repeat the second and third steps until the transition

³⁷ See Berger et al. (2009) for an example of a cost-function estimation for Chinese banks.

matrix and flow utility converge. 6) Given this set of demand parameters, I compute the value function of the monopoly bank and obtain the equilibrium service fees from the policy rule. Finally, I repeat steps 2-6 until the sequence of service fees converges.

Table 7 presents the equilibrium service fees set by the monopoly bank for various combinations of switching costs and initial market shares. The choice of initial market shares for the monopoly bank are based on practical considerations because the total market share of the four SCBs were approximately 75% in the early 1990s but dropped to 60% in 2004, which is the last year that Chinese banks were regulated to set the same deposit rate. Thus, I begin with the initial market share at 75%, and then, I reduce it to 60% ($= 75\% \times 0.8$). To highlight the role of the switching cost in the pricing decision of the monopoly bank, I reduce the switching cost to 80% of its estimated value, i.e., $\tau = 1.58 \times 0.8 = 1.26$, and re-estimate the parameters $\{\gamma_{m1}, \gamma_{m2}, \sigma_m\}$ as $\{0.15, 0.40, 0.06\}$ according to the previously described procedure.³⁸

The first row of Table 7 shows that given the estimated switching cost, the monopoly bank reduces its service fees from 0.54% to 0.52% when its market share decreases from 75% to 60%. Furthermore, the last row of Table 7 shows that when the switching cost is set at 80% of its current estimated value, the monopoly bank sets its service fees at 0.47% and 0.44% when its initial market shares are 75% and 60%, respectively. The analysis suggests that reducing the switching cost has a comparable competitive effect on bank pricing to reducing the dominant position of the monopoly.

8. Conclusion

This paper explores the relevance of switching cost in the Chinese deposit market and its possible effects on consumer preferences, the price elasticity of demand and bank pricing. I extend the static demand model to incorporate the transaction costs for consumers to switch banks; the result is a dynamic model in which consumers are forward-looking and make decisions on which bank to use based on the service quality, the switching costs and an idiosyncratic component of preferences. I show that consumers prefer banks with more branches and employees. Consumers incur approximately 0.8% of their deposit values as switching costs when they switch their deposit institutions. Because consumers adjust their bank choices gradually, the static demand model biases the consumers' willingness to pay for bank attributes and underestimates the price elasticity. Then, I perform counterfactual experiments with a dynamic monopoly model to show that in addition to introducing competition, reducing the switching cost can be an effective way to ensure that bank pricing is competitive.

Finally, the use of this stylized dynamic structural model to estimate the magnitude and pricing effect of the switching cost in the banking industry has some caveats, which will require future research that captures more features of the banking industry. First, a more comprehensive setting should be

³⁸ The case for a switching cost at 90% of its estimated value is analyzed in an analogous way.

considered to model bank operations in the deposit and loan markets or to model banks that provide multiple products, such as demand deposits, time deposits, loans and investment services. Second, the long-run price elasticity still falls short of the unitary elasticity, which is not fully consistent with profit maximization. To rationalize this feature, it would be interesting to examine the effect of non-profit objectives, such as bailing out state-owned enterprises, on bank behavior. Third, it would be interesting to extend the demand model to overcome the problem of IIA and allow for a richer structure of consumer heterogeneity.

References

- Adams, Robert M., Kenneth P. Brevoort and Elizabeth K. Kiser (2007), "Who Competes with Whom? The Case of Depository Institutions," *Journal of Industrial Economics*, LV(March): 141-67.
- Allen, Franklin, Jun Qian and Meijun Qian (2008), "China's Financial System: Past, Present and Future," in Loren Brandt and Thomas Rawski, eds., *China's Economic Transition: Origins, Mechanism, and Consequences*, Cambridge University Press: 506-68.
- Allen, Jason, Robert Clark and Jean Francois Houde (2008), "Market Concentration and the Diffusion of Electronic Banking," Bank of Canada Working Paper, 2008-32.
- Amel, Dean F. and Martha Starr-McCluer (2002), "Market Definition in Banking: Recent Evidence," *The Antitrust Bulletin*, 47(1): 63-89.
- Berger, Allen N., Iftekhar Hasan and Mingming Zhou (2009), "Bank Ownership and Efficiency in China: What Will Happen in the World's Largest Nation?" *Journal of Banking and Finance*, 33: 113-30.
- Berry, Steven (1994), "Estimating Discrete Choice Models of Product Differentiation," *RAND Journal of Economics*, 25: 242-62.
- Berry, Steven, James Levinsohn and Ariel Pakes (1995), "Automobile Prices in Market Equilibrium," *Econometrica*, 63: 841-90.
- Cull, Robert and Lixin Xu (2000), "Bureaucrats, State Banks, and the Efficiency of Credit Allocation: The Experience of Chinese State-Owned Enterprises," *Journal of Comparative Economics*, 28: 1-31.
- Cull, Robert and Lixin Xu (2003), "Why Get Credit? The Behavior of Bureaucrats and State Banks in Allocating Credit to Chinese State-Owned Enterprises," *Journal of Development Economics*, 71: 533-59.
- Dick, Astrid (2008) "Demand Estimation and Consumer Welfare in the Banking Industry," *Journal of Banking and Finance*, 32: 1661-76.
- Dobson, Wendy and A Kashyap (2006), "The Contradiction in China's Gradualist Banking Reforms," *Brookings Papers of Economic Activity*, 2: 103-48.
- Dube, Jean-Pierre, Gunter J. Hitsch and Peter E. Rossi (2009), "Do Switching Costs Make Markets Less Competitive?" *Journal of Marketing Research*, 46(4): 435-45.

- Farrell, Diana, Susan Lund and Fabrice Morin (2006), "How Financial-System Reform Could Benefit China," *The McKinsey Quarterly*, special edition on serving the new Chinese consumer.
- Gowrisankaran, Gautam and Marc Rysman (2012), "Dynamics of Consumer Demand for New Durable Goods," *Journal of Political Economy*, 120(6): 1173-219.
- Gustafsson, Bjorn, Shi Li and Zhong Wei (2006), "The Distribution of Wealth in Urban China and in China as a Whole in 1995," *Review of Income and Wealth*, 52(2): 173-88.
- Hannan, Timothy H. and Robert M. Admans (2011), "Consumer Switching Costs and Firm Pricing: Evidence from Bank Pricing of Deposit Accounts," *Journal of Industrial Economics*, 59(2): 296-320.
- Hao, Chen (2006), "Development of Financial Intermediation and Economic Growth: The Chinese Experience," *China Economic Review*, 17(4): 347-62.
- Ho, Chun-Yu (2010), "Deregulation, Competition and Consumer Welfare in Banking Market: Evidence from Hong Kong," *Journal of Regulatory Economics*, 37(1): 70-97.
- Ho, Chun-Yu (2012), "Market Structure, Welfare and Banking Reform in China," *Journal of Comparative Economics*, 40(2): 291-313.
- Ho, Katherine and Joy Ishii (2011), "Location and Competition in Retail Banking," *International Journal of Industrial Organization*, 29(5): 537-46.
- International Monetary Fund (1996), "Monetary and Exchange System Reforms in China: An Experiment in Gradualism," Occasional Paper No.141.
- Ishii, Joy (2008), "Compatibility, Competition, and Investment in Network Industries: ATM Networks in the Banking Industry," mimeo.
- Kim, Moshe, Doron Kliger and Bent Vale (2003), "Estimating Switching Costs and Oligopolistic Behaviour: The Case of Banking," *Journal of Financial Intermediation*, 12(1): 25-56.
- King, Robert G. and Ross Levine (1993), "Finance and Growth: Schumpeter Might Be Right," *Quarterly Journal of Economics*, 108(3): 717-38.
- Klemperer, Paul (1995), "Competition when Consumers have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics and International Trade," *Review of Economic Studies*, 62: 513-39.

- Kiser, Elizabeth (2002), "Predicting Household Switching Behavior and Switching Costs at Depository Institutions," *Review of Industrial Organization*, 20: 349-65.
- Knittel, Christopher and Victor Stango (2008), "Incompatibility, Product Attributes and Consumer Welfare: Evidence from ATM," *BE Journal of Economic Analysis and Policy, Advances*, 8(1).
- Lee, Robin (2013), "Vertical Integration and Exclusivity in Platform and Two-Sided Markets," *American Economic Review*, 103(7): 2960-3000.
- Molnar, Jozsef (2008), "Market Power and Merger Simulation in Retail Banking," Bank of Finland, Discussion Paper 4.
- Molnar, Jozsef, Marton Nagy and Csilla Horvath (2007), "A Structural Empirical Analysis of Retail Banking Competition: The Case of Hungary," MNB Working Papers 2007/1, Magyar Nemzeti Bank.
- Nakane, Marcio I, Leonardo S. Alencar and Fabio Kanczuk (2006), "Demand for Bank Services and Market Power in Brazilian Banking," Banco Central do Brazil, Working Paper 107.
- Magnac, Thierry and David Thesmar (2002), "Identifying Dynamic Discrete Decision Processes," *Econometrica*, 70(2): 801-16.
- Nevo, Aviv (2000), "Mergers with Differentiated Products: The Case of the Ready-To-Eat Cereal Industry," *Rand Journal of Economics*, 31: 395-421.
- Park, Albert and Kaja Sehr (2001), "Tests of Financial Intermediation and Banking Reform in China," *Journal of Comparative Economics*, 29(4): 608-44.
- Shcherbakov, Oleksander (2009), "Measuring Consumer Switching Costs in the Television Industry," mimeo, University of Mannheim.
- Schiraldi, Pasquale (2011), "Automobile Replacement: A Dynamic Structural Approach," *Rand Journal of Economics*, 42(2, Summer): 266-91.
- Sharpe, Steven A. (1997), "The Effect of Consumer Switching Costs on Prices: A Theory and its Application to the Bank Deposit Market," *Review of Industrial Organization*, 12: 79-94.
- Shea, John (1997), "Instrument Relevance in Multivariate Linear Models: A Simple Measure," *Review of Economics and Statistics*, 79(2): 348-52.
- Zhao, Emily (2008), "Why are Prices Falling Fast? An Empirical Study of the US Digital Camera Market," mimeo, Yale University.

Table 1. Bank Attributes, 1994-2001

Bank/Year	Market Share		Employees/ Branch		Branch Density	
	1994	2001	1994	2001	1994	2001
<i>ABC</i>	19%	16%	9.93	11.45	0.016	0.013
<i>BOC</i>	7%	8%	16.98	15.08	0.004	0.004
<i>CCB</i>	15%	17%	36.15	26.97	0.003	0.005
<i>ICBC</i>	31%	26%	16.13	15.59	0.012	0.011

Bank/Year	Total number of Branches		ATMs/ Branch		Service Fees	
	1994	2001	1994	2001	1994	2001
<i>ABC</i>	63284	43905	0.21	0.91	0.05%	0.09%
<i>BOC</i>	12612	12508	0.31	1.20	0.29%	0.21%
<i>CCB</i>	10477	12876	0.85	1.80	0.13%	0.14%
<i>ICBC</i>	37033	28344	0.27	0.90	0.04%	0.09%

This table reports the market outcomes and bank attributes of all four SCBs for 1994 and 2001. Whereas the Market shares, Employees per Branch and Branch density have variations at the bank-province-year level, the other variables have variations at the bank-year level. The market share, employees per branch and branch density are averages across all of the provinces in those two years.

Table 2. Estimation Results

Variable	Dynamic-1	Dynamic-2	Myopia	WTP-1	WTP-2	WTP-M
Demand - linear						
Service Fees	-192 (35.3) [*]	-113 (26.5) [*]	-100 (33.7) [*]	0.10%	0.10%	0.10%
Employees/Branch (x100)	0.37 (0.17) [*]	0.33 (0.13) [*]	0.31 (0.17) ^{**}	0.02%	0.03%	0.03%
Branch Density	5.78 (1.51) [*]	5.71 (1.13) [*]	8.37 (1.44) [*]	0.04%	0.07%	0.11%
Total Branches	0.11 (0.03) [*]	0.07 (0.03) [*]	0.04 (0.03)	0.11%	0.12%	0.08%
ATMs/Branches	0.09 (0.19)	0.08 (0.13)	-0.02 (0.16)	0.02%	0.03%	-0.01%
RCC Density	-1.83 (5.26)	-0.06 (5.26)	-0.93 (5.02)			
Real GDP	114 (35.8) [*]	61.4 (26.7)	55.2 (34.2)			
Agricultural Share of GDP	0.99 (0.72)	0.85 (0.54)	2.33 (0.69) [*]			
Provincial Dummies	Yes	Yes				
Year Dummies	Yes	Yes				
Bank Dummies	Yes	Yes				
Demand - Nonlinear						
Switching Cost	1.50 (0.93) ^{##}	0.95 (0.55) [#]	/	0.08%	0.08%	/
J-statistic	1.86	1.99	1.80			

Data variations at the bank-province-year level. The numbers of sample observations are 708. The first three columns report the estimation results of the demand system. The dependent variable of the linear part is the flow utility $\delta_{jmt}^f(s_{mt})$. The estimated standard errors are in parentheses. * Significant at the 5% level; ** significant at the 10% level for a two-sided test; # significant at the 5% level; ## significant at the 10% level for a one-sided test. The J-statistic = $N \cdot GMM$ follows the Chi-square distribution and the degrees of freedom = No. of instruments - No. of parameters = 13 and 5 for the first two columns and the third column, respectively. The last three columns report the welfare gained from increasing each bank attribute by 1 SD. In addition, Mean and SD are the sample mean and standard deviation of the corresponding variable. Lastly, WTP is the Utility/Coefficient of the service fee, where Utility is the demand coefficient for the corresponding variable multiplied by the SD. The units for WTP are % of deposits.

Table 3-1. Forecasting Equation

Parameter	ABC	BOC	CCB	ICBC	Outside
γ_{11}	-0.12 (0.02)*	-0.27 (0.04)*	-0.10 (0.02)*	-0.06 (0.02)*	N/A
γ_{12}	0.56 (0.05)*	0.60 (0.05)*	0.60 (0.05)*	0.54 (0.05)*	N/A
σ_1	0.16	0.19	0.20	0.23	N/A
Corr(e_t, e_{t-1})	-0.36*	-0.16*	-0.34*	-0.38*	N/A
Parameter	ABC	BOC	CCB	ICBC	Outside
γ_{21}	5.06 (0.54)*	5.07 (0.54)*	5.37 (0.55)*	5.00 (0.54)*	4.71 (0.53)*
γ_{22}	0.50 (0.05)*	0.50 (0.05)*	0.46 (0.05)*	0.50 (0.05)*	0.52 (0.05)*
σ_2	0.32	0.32	0.31	0.28	0.37
Corr(e_t, e_{t-1})	-0.40*	-0.41*	-0.38*	-0.40*	-0.40*

This table reports the linear forecasting rules of consumers for their current bank and other banks in the market. The estimated standard errors are in parentheses. *Significant at the 5% level; ** significant at the 10% level.

Table 3-2. Forecasting Equation

Parameter	ABC	BOC	CCB	ICBC	Outside
γ_{11}	-0.04 (0.01)*	-0.06 (0.03)*	-0.06 (0.01)*	-0.04 (0.02)*	N/A
γ_{12}	0.23 (0.08)*	0.63 (0.09)*	0.57 (0.08)*	0.23 (0.08)*	N/A
σ_1	0.11	0.12	0.03	0.16	N/A
Corr(e_t, e_{t-1})	0.02	-0.02	-0.21*	-0.12	N/A
Parameter	ABC	BOC	CCB	ICBC	Outside
γ_{21}	0.95 (0.23)*	1.02 (0.23)*	1.02 (0.25)*	1.00 (0.24)*	0.86 (0.23)*
γ_{22}	0.14 (0.08)**	0.14 (0.08)**	0.13 (0.08)**	0.24 (0.09)*	0.20 (0.08)*
σ_2	0.12	0.12	0.12	0.10	0.17
Corr(e_t, e_{t-1})	0.07	0.08	0.08	0.11	0.09

This table reports the linear forecasting rules of consumers for their current bank and other banks in the market. The estimated standard errors are in parentheses. The second-order autoregressive term is included in all specifications, but the results are omitted. *Significant at the 5% level; ** significant at the 10% level.

Table 4. Price Elasticity

Panel A: Short-run Price Elasticity					Panel B: Long-run Price Elasticity				
Bank	ABC	BOC	CCB	ICBC	Bank	ABC	BOC	CCB	ICBC
ABC	-0.26	0.05	0.05	0.05	ABC	-0.37	0.05	0.07	0.08
BOC	0.05	-0.43	0.05	0.05	BOC	0.05	-0.77	0.06	0.07
CCB	0.05	0.05	-0.20	0.05	CCB	0.06	0.05	-0.36	0.08
ICBC	0.05	0.05	0.05	-0.11	ICBC	0.07	0.06	0.07	-0.19
Outside	0.05	0.05	0.05	0.05	Outside	0.07	0.06	0.07	0.08

Note: The results are computed from the dynamic model with the optimal weighting matrix.

Table 5. Short-Run Price Elasticity

Panel A: Existing Consumers					Panel B: Incoming Consumers				
Bank	ABC	BOC	CCB	ICBC	Bank	ABC	BOC	CCB	ICBC
ABC	-0.25	0.05	0.05	0.05	ABC	-0.30	0.11	0.07	0.05
BOC	0.04	-0.40	0.05	0.05	BOC	0.07	-0.63	0.07	0.05
CCB	0.05	0.05	-0.19	0.05	CCB	0.07	0.11	-0.29	0.05
ICBC	0.05	0.04	0.05	-0.10	ICBC	0.07	0.11	0.07	-0.17
Outside	0.05	0.04	0.05	0.05	Outside	0.07	0.11	0.07	0.05

Note: The results are computed from the dynamic model with the optimal weighting matrix.

Table 6. Price Elasticity of Myopic Consumers

Bank	ABC	BOC	CCB	ICBC
ABC	-0.10	0.02	0.02	0.02
BOC	0.02	-0.26	0.02	0.02
CCB	0.02	0.02	-0.09	0.02
ICBC	0.02	0.02	0.02	-0.05
Outside	0.02	0.02	0.02	0.02

Note: The results are computed from the static model estimated with 2SLS.

Table 7. Equilibrium Service Fees of a Dynamic Monopoly

Multiple of the Switching Cost	Multiple of the Initial Market Share		
	1	0.9	0.8
1	0.54%	0.53%	0.52%
0.9	0.51%	0.50%	0.49%
0.8	0.47%	0.46%	0.44%

Note: The table shows the solutions of the dynamic monopoly model for various combinations of switching cost (τ) and initial market share (s_{mt-1}). Because the initial market share is set to 75%, the initial market shares at multiples of 1, 0.9 and 0.8 are 75%, 67.5% and 60%, respectively. Given an estimated switching cost of 1.50 (see Table 2), switching costs at multiples of 1, 0.9 and 0.8 imply counterfactual switching costs of 1.50, 1.35 and 1.20, respectively. Units: Percentages of the total deposit values.

Appendix 1. Data and Descriptive Statistics

This appendix provides more details on the dataset and reports the descriptive statistics of the variables used in the empirical analysis in Table A1. These data are collected from various issues of the Almanac of China Finance and Banking (the Almanacs, hereafter) and the China Statistics Yearbook (the Yearbooks, hereafter). Data on balance sheets, income statements, provincial deposits, provincial branches and provincial employees were obtained from the Almanacs. Provincial demographic and economic data are obtained from the Yearbooks.

The sample contains a total of 828 annual observations at the level of bank-market-year and covers the years 1994 to 2001. According to the Almanac, the deposit data for each bank at the provincial level are available until 2004. On the other hand, the branch and employee data for each bank at the provincial level are available until 2001. Thus, the empirical analysis is limited to the period 1994-2001. Furthermore, as some data are missing for the ICBC, I exclude (1) the year 1997; (2) the Tibet province and (3) Chongqing for 1994-1996.

Table A1. Descriptive Statistics

Variable	Mean (SD)	Median	Mean (SD)	Mean (SD)
<i>Market/Demographic Information</i>				
	Full	Full	1994	2001
<i>RCC density (branches per km²)</i>	0.010 (0.007)	0.009	0.011 (0.007)	0.008 (0.007)
<i>Real GDP (million Yuan at the 1993 price level)</i>	1.718 (1.369)	1.350	1.247 (0.927)	2.253 (1.762)
<i>Agricultural share of GDP (%/100)</i>	0.199 (0.083)	0.207	0.220 (0.082)	0.166 (0.073)
<i>Market Share</i>				
<i>s_{jmt} (%/100)</i>	0.175 (0.089)	0.161	0.180 (0.099)	0.169 (0.071)
<i>Price</i>				
<i>Service fee (%/100)</i>	0.0014 (0.0010)	0.0009	0.0012 (0.0010)	0.0013 (0.0005)
<i>Deposit rate (%/100)</i>	0.019 (0.009)	0.016	0.011	0.023
<i>Bank Characteristics</i>				
<i>Employees/Branch (people)</i>	17.75 (10.40)	14.46	19.80 (13.66)	17.27 (7.80)
<i>Branch density (branches per km²)</i>	0.009 (0.013)	0.005	0.009 (0.013)	0.008 (0.013)
<i>Total Branches (10,00 units)</i>	2.99 (1.88)	2.18	3.09 (2.15)	2.44 (1.30)
<i>ATMs/Branch (1 unit)</i>	0.93 (0.46)	0.85	0.41 (0.26)	1.20 (0.37)
<i>Instruments</i>				
<i>Cash/Employee</i>	0.0006 (0.0003)	0.0005	0.0004 (0.0001)	0.0007 (0.0002)
<i>Equity/Employee</i>	0.0035 (0.0026)	0.0033	0.0017 (0.0010)	0.0058 (0.0037)
<i>Loan/Asset (per Yuan assets)</i>	0.590 (0.081)	0.610	0.543 (0.082)	0.573 (0.066)
<i>rival Employees/Branch (People)</i>	17.75 (10.40)	16.34	19.80 (7.92)	17.27 (3.95)
<i>rival Branch density (branches per km²)</i>	0.009 (0.011)	0.006	0.009 (0.010)	0.008 (0.011)
<i>rival ATM/Branch (1 unit)</i>	0.79 (0.27)	0.87	0.30 (0.05)	1.08 (0.09)

Note: This table reports the descriptive statistics for the variables used in the estimation. The sample contains 828 observations, with 116 observations in 1994 (third column) and 120 for year 2001. These figures are computed over the sample period indicated. Standard deviations are in brackets.

Appendix 2. Static Logit Demand and Instrumental Variables

This appendix estimates a static model of logit demand to examine the explanatory power of bank characteristics on mean utility and the usefulness of the instruments to control for endogeneity on service fees. Following Berry (1994), the logit demand equation takes the following form

$$\ln(s_{jmt} / s_{omt}) = x_{jmt} \beta_x - \alpha p_{jt} + \xi_{jmt} \quad \text{where} \quad \xi_{jmt} = \zeta_j + \zeta_m + \zeta_t + \zeta_{jmt}$$

The decomposition of error term follows Equation (14). The results from the OLS estimation of the static logit demand are reported in Table A2. The R-squared of the OLS estimation is 0.87, implying that 87% of the mean utility is explained by the observed bank characteristics, service fees and other control variables. A specification with only bank attributes, real GDP and agricultural share of GDP produces an R-squared of 0.61. This suggests that both observed and unobserved components across banks, provinces and years are important to explain the variations of the dependent variable. Since the lagged variables are used to estimate switching cost in the dynamic demand model, I do not include the initial year of each province to estimate the static demand model in order to let the samples used to estimate the static demand model and the dynamic demand model consistent with each other.

Table A2. Estimation Results

Variables	1st Stage	OLS	2SLS
<i>Pfee</i>		-29.72*	-99.98***
		(17.70)	(33.69)
<i>Employees/Branch</i>	0.000	0.00335**	0.00310*
	(0.000)	(0.00169)	(0.00166)
<i>Branch density</i>	0.000	8.444***	8.372***
	(0.006)	(1.468)	(1.436)
<i>Total branches</i>	0.0005***	0.00733	0.0410
	(0.000)	(0.0298)	(0.0323)
<i>ATMs/Branches</i>	-0.0002	0.151	-0.0152
	(0.0005)	(0.151)	(0.163)
<i>RCC Density</i>	0.000	-0.928	-0.928
	(0.010)	(5.128)	(5.018)
<i>Real GDP</i>	0.000	55.16	55.22
	(0.073)	(34.92)	(34.16)
<i>Agricultural share of GDP</i>	0.000	2.336***	2.326***
	(0.001)	(0.706)	(0.691)
<i>Cash/Employee</i>	0.643**		
	(0.244)		
<i>Equity/Employee</i>	-0.247***		
	(0.029)		
<i>Loan/Assets</i>	-0.003***		
	(0.001)		
<i>Rival Employees/Branch</i>	0.000		
	(0.000)		
<i>Rival Branch density</i>	0.000		
	(0.019)		
<i>Rival ATM/Branch</i>	0.009***		
	(0.002)		
<i>Bank FE</i>	Yes	Yes	Yes
<i>Year FE</i>	Yes	Yes	Yes
<i>Province FE</i>	Yes	Yes	Yes
<i>Shea Partial R²</i>			0.264
<i>F-test (p-value)</i>			0.000
<i>Sargan test (p-value)</i>			0.845
<i>R-squared</i>	0.837	0.870	0.866

Number of observations is 708 observations. The first and the remaining two columns report the first- and second-stage regressions of the logit demand model, respectively. The dependent variable in the first-stage price regression is p_i and that in the flow utility equation is $\delta_{jmt}^f(s_{mt}) = \ln(s_{jmt}/s_{omt})$. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Instrumental Variables (IVs)

Service fees are computed from the ratio of income from commissions to total deposits. Although the central bank sets the fees for various types of basic deposit services such as cashing a check, there are several reasons for the average service fees to vary across banks. First, banks can set their service fees below benchmark levels to undercut other banks and attract more consumers. However, they cannot raise the service fees above those set by the central bank. Second, banks can set fees for newly developed services upon the approval of the central bank. For example, if a bank provides a higher quality of service to its customers, the bank is less likely to undercut in price because it incurs a higher cost for providing better services and developing new products. As a result, equilibrium prices depend on the observed and unobserved product characteristics, and therefore the regressors (p_{jt}) are correlated with the unobservables (ζ_{jmt}). The correlation is positive, and therefore the OLS estimator of α is biased towards zero (i.e., it underestimates own-price elasticity). I handle this endogeneity problem using the instrumental variable approach. To estimate the demand equation, I apply two sets of instruments to identify the coefficients on service fees.

Cost shifters related to funding cost and financial structure can be valid instruments because they affect service fees through the bank pricing decisions but are unrelated to the unobserved demand factor. The first set of IVs consists of the following cost shifters: ($Loan/Asset_{jt}$, $Cash/Employee_{jt}$, $Equity/Employee_{jt}$). The first cost shifter relates to the financial structure of the bank. I include the ratio of loans to total assets to capture the credit risk of banks. Banks with high levels of credit risk may face higher costs of operation and increased auditing needs, boosting the marginal cost. Additionally, liquidity and capitalization variables are informative about the marginal cost because more liquid and capitalized banks have an easier time accessing funding. I use the ratio of cash to total employment and equity to total employment as proxies for bank liquidity and capitalization. These variables are obtained from the bank balance sheets reported in the Almanac.

Moreover, I augment the first set of instruments with the following three markup shifters: ($rival\ Employees/Branch_{jmt}$, $rival\ Branch\ Density_{jmt}$, $rival\ ATMs/Branch_{jt}$). Service fees are determined by the relative locations of banks. For example, a bank may charge a lower service fee when it faces a close competitor. I construct this set of instruments using the average observed characteristics of rival banks in each market (Berry et al., 1995). Given that product characteristics are exogenous, these instruments are orthogonal to unobserved product characteristics. Appendix A1 reports the descriptive statistics of all instruments.

IVs: Estimation, Relevance and Validity

Table A2 reports the results from the 2SLS estimation. The 2SLS estimation produces a more negative coefficient for the service fees, which suggests that the unobserved product characteristics creates endogeneity for service fees in the OLS estimation. To establish the credibility of the results

from the 2SLS estimation, I test the relevance and validity of the instruments. Specifically, I test whether the IVs are correlated with the endogenous regressor and are orthogonal to the error process.

The coefficient estimates and their corresponding standard errors of first-stage regression are shown in Table A2. The F-test rejects the null hypothesis that the instruments are jointly insignificant in the first-stage regression. Moreover, the first-stage Shea R-squared shows that the partial R-squared is approximately 26%, which is reasonable. Because the value for the partial R-squared is above 10%, the instruments are relevant in Shea's (1997) sense, which in turn implies that the instruments have sufficient relevance for the endogenous variable in the mean utility regression.

I also assess the validity of the instruments using the Sargan test for over-identifying restrictions. The 2SLS regression is based on the assumption that the instruments are not correlated with the error term in the mean utility equation. The p-value of the Sargan test is reported at the bottom of Table A2. This test cannot reject the null hypothesis that the instruments are not correlated with the error term, which suggests that the instruments affect service fees but not mean utility. Thus, the chosen instruments are both relevant and valid for service fees.

Appendix 3. Proof of the Proposition

Using the law of motion (11) with $\lambda=1$, the steady state market shares can be solved from the following system of equations:

$$\begin{aligned}
 s_a &= s_b \frac{P(b \rightarrow a)}{1 - P(a \rightarrow a)} + s_c \frac{P(c \rightarrow a)}{1 - P(a \rightarrow a)} + s_d \frac{P(d \rightarrow a)}{1 - P(a \rightarrow a)} + s_o \frac{P(o \rightarrow a)}{1 - P(a \rightarrow a)} \\
 s_b &= s_a \frac{P(a \rightarrow b)}{1 - P(b \rightarrow b)} + s_c \frac{P(c \rightarrow b)}{1 - P(b \rightarrow b)} + s_d \frac{P(d \rightarrow b)}{1 - P(b \rightarrow b)} + s_o \frac{P(o \rightarrow b)}{1 - P(b \rightarrow b)} \\
 s_c &= s_a \frac{P(a \rightarrow c)}{1 - P(c \rightarrow c)} + s_b \frac{P(b \rightarrow c)}{1 - P(c \rightarrow c)} + s_d \frac{P(d \rightarrow c)}{1 - P(c \rightarrow c)} + s_o \frac{P(o \rightarrow c)}{1 - P(c \rightarrow c)} \\
 s_d &= s_a \frac{P(a \rightarrow d)}{1 - P(d \rightarrow d)} + s_b \frac{P(b \rightarrow d)}{1 - P(d \rightarrow d)} + s_c \frac{P(c \rightarrow d)}{1 - P(d \rightarrow d)} + s_o \frac{P(o \rightarrow d)}{1 - P(d \rightarrow d)} \\
 s_o &= s_a \frac{P(a \rightarrow o)}{1 - P(o \rightarrow o)} + s_b \frac{P(b \rightarrow o)}{1 - P(o \rightarrow o)} + s_c \frac{P(c \rightarrow o)}{1 - P(o \rightarrow o)} + s_d \frac{P(d \rightarrow o)}{1 - P(o \rightarrow o)}
 \end{aligned}$$

The system can be reduced to

$$\begin{aligned}
 s_a &= s_b K_{ab} + s_c K_{ac} + s_d K_{ad} \\
 s_b &= s_c K_{bc} + s_d K_{bd} + s_o K_{bo} \\
 s_c &= s_a K_{ca} + s_d K_{cd} + s_o K_{co} \\
 s_d &= s_a K_{da} + s_b K_{db} + s_o K_{do}
 \end{aligned}
 , \text{ where}$$

$$\begin{aligned}
 K_{ab} &= \frac{P(b \rightarrow o)P(o \rightarrow a) + P(b \rightarrow a)[1 - P(o \rightarrow o)]}{[1 - P(o \rightarrow o)][1 - P(a \rightarrow a)] - P(a \rightarrow o)P(o \rightarrow a)} \\
 K_{ac} &= \frac{P(c \rightarrow o)P(o \rightarrow a) + P(c \rightarrow a)[1 - P(o \rightarrow o)]}{[1 - P(o \rightarrow o)][1 - P(a \rightarrow a)] - P(a \rightarrow o)P(o \rightarrow a)} \\
 K_{ad} &= \frac{P(d \rightarrow o)P(o \rightarrow a) + P(d \rightarrow a)[1 - P(o \rightarrow o)]}{[1 - P(o \rightarrow o)][1 - P(a \rightarrow a)] - P(a \rightarrow o)P(o \rightarrow a)}
 \end{aligned}$$

$$\begin{aligned}
 K_{bc} &= \frac{P(c \rightarrow a)P(a \rightarrow b) + P(c \rightarrow b)[1 - P(a \rightarrow a)]}{[1 - P(a \rightarrow a)][1 - P(b \rightarrow b)] - P(b \rightarrow a)P(a \rightarrow b)} \\
 K_{bd} &= \frac{P(d \rightarrow a)P(a \rightarrow b) + P(d \rightarrow b)[1 - P(a \rightarrow a)]}{[1 - P(a \rightarrow a)][1 - P(b \rightarrow b)] - P(b \rightarrow a)P(a \rightarrow b)} \\
 K_{bo} &= \frac{P(o \rightarrow a)P(a \rightarrow b) + P(o \rightarrow b)[1 - P(a \rightarrow a)]}{[1 - P(a \rightarrow a)][1 - P(b \rightarrow b)] - P(b \rightarrow a)P(a \rightarrow b)}
 \end{aligned}$$

$$\begin{aligned}
K_{ca} &= \frac{P(a \rightarrow b)P(b \rightarrow c) + P(a \rightarrow c)[1 - P(b \rightarrow b)]}{[1 - P(b \rightarrow b)][1 - P(c \rightarrow c)] - P(c \rightarrow b)P(b \rightarrow c)} \\
K_{cd} &= \frac{P(d \rightarrow b)P(b \rightarrow c) + P(d \rightarrow c)[1 - P(b \rightarrow b)]}{[1 - P(b \rightarrow b)][1 - P(c \rightarrow c)] - P(c \rightarrow b)P(b \rightarrow c)} \quad \text{and} \\
K_{co} &= \frac{P(o \rightarrow b)P(b \rightarrow c) + P(o \rightarrow c)[1 - P(b \rightarrow b)]}{[1 - P(b \rightarrow b)][1 - P(c \rightarrow c)] - P(c \rightarrow b)P(b \rightarrow c)}
\end{aligned}$$

$$\begin{aligned}
K_{da} &= \frac{P(a \rightarrow c)P(c \rightarrow d) + P(a \rightarrow d)[1 - P(c \rightarrow c)]}{[1 - P(c \rightarrow c)][1 - P(d \rightarrow d)] - P(d \rightarrow c)P(c \rightarrow d)} \\
K_{db} &= \frac{P(b \rightarrow c)P(c \rightarrow d) + P(b \rightarrow d)[1 - P(c \rightarrow c)]}{[1 - P(c \rightarrow c)][1 - P(d \rightarrow d)] - P(d \rightarrow c)P(c \rightarrow d)} \quad . \text{ Substituting } s_a \text{ into } s_b, s_c \text{ and } s_d, \\
K_{do} &= \frac{P(o \rightarrow c)P(c \rightarrow d) + P(o \rightarrow d)[1 - P(c \rightarrow c)]}{[1 - P(c \rightarrow c)][1 - P(d \rightarrow d)] - P(d \rightarrow c)P(c \rightarrow d)}
\end{aligned}$$

$$\begin{aligned}
s_b &= M_b + s_c M_{bc} + s_d M_{bd} \\
\text{we have } s_c &= M_c + s_b M_{cb} + s_d M_{cd}, \text{ where } M_{ac} \\
s_d &= M_d + s_b M_{db} + s_c M_{dc}
\end{aligned}
\quad
\begin{aligned}
M_b &= \frac{K_{bo}}{1 + K_{bo} + K_{ab} K_{bo}} \\
M_{ac} &= \frac{K_{bc} - K_{bo} - K_{ac} K_{bo}}{1 + K_{bo} + K_{ab} K_{bo}} \\
M_{ad} &= \frac{K_{bd} - K_{bo} - K_{ad} K_{bo}}{1 + K_{bo} + K_{ab} K_{bo}}
\end{aligned}$$

$$\begin{aligned}
M_c &= \frac{K_{co}}{1 + K_{co} - K_{ac}(K_{ca} - K_{co})} \\
M_{cb} &= \frac{K_{ab}(K_{ca} - K_{co}) - K_{co}}{1 + K_{co} - K_{ac}(K_{ca} - K_{co})} \quad \text{and} \\
M_{cd} &= \frac{K_{ad}(K_{ca} - K_{co}) + K_{cd} - K_{co}}{1 + K_{co} - K_{ac}(K_{ca} - K_{co})} \\
M_d &= \frac{K_{do}}{1 + K_{do} - K_{ad}(K_{da} - K_{do})} \\
M_{db} &= \frac{K_{ab}(K_{da} - K_{do}) + K_{db} - K_{do}}{1 + K_{do} - K_{ad}(K_{da} - K_{do})} \\
M_{dc} &= \frac{K_{ac}(K_{da} - K_{do}) - K_{do}}{1 + K_{do} - K_{ad}(K_{da} - K_{do})}
\end{aligned}$$

Substituting s_b into s_c and s_d , we have

$$\begin{aligned}
s_c &= \frac{M_c + M_b M_{cb}}{1 - M_{bc} M_{cb}} + s_d \frac{M_{cd} + M_{cb} M_{bd}}{1 - M_{bc} M_{cb}} \equiv N_c + s_d N_{cd} \\
s_d &= \frac{M_d + M_b M_{db}}{1 - M_{bd} M_{db}} + s_c \frac{M_{dc} + M_{db} M_{bc}}{1 - M_{bd} M_{db}} \equiv N_d + s_c N_{dc}
\end{aligned}
\quad \text{and the solutions of the system of}$$

equations are characterized as $s_c = \frac{N_c + N_d N_{dc}}{1 - N_{cd} N_{dc}}$ and $s_d = \frac{N_d + N_c N_{cd}}{1 - N_{cd} N_{dc}}$. As a result, the steady state market shares are $S_j(\tau, \delta_{at}^f, \delta_{bt}^f, \delta_{ct}^f, \delta_{dt}^f)$.